Interlocking for marshalling yards

AlisterCargo

CONTENTS:

Introduction 3

Technical Details 5

System Functionality 12

References 13

- Trafikverket - Sweden 13
- FTIA - Finland 14
- LKAB Sweden 14
- DSB/Banedanmark - Danmark 15

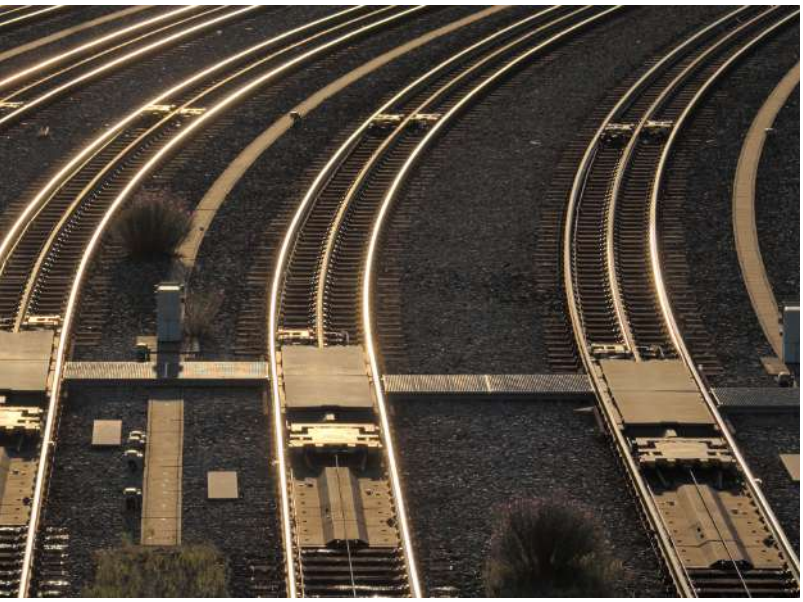
INTRODUCTION

With rail-bound cargo traffic increasing, the demands for safe and efficient operation of marshalling yards, depots, harbours and industrial sidings have likewise increased.

To meet these demands the electronic interlocking system AlisterCargo has been developed in accordance with the principles of the standards EN50xxx.

The main function of AlisterCargo is to control and monitor all trackside objects (signals, points, brakes, train detection systems etc), including diagnostic and service properties.

Operation can either be controlled from a central operations control centre and/or locally at special route setting panels installed close to the tracks.



Long term availability of all system components is guaranteed through a modern system architecture composed of reliable, well known and thoroughly tested standard components and development tools from other industrial sectors with very high safety demands.

The advantages of such a system are low development costs, system flexibility and excellent future upgrade possibilities. Standardized industrial software is the base for all system processes, as is processing and visualization of messages or system alerts. Simple and user-friendly software significantly reduces the demands and costs of the operator training.

The modular AlisterCargo design concept makes the system easy to adapt to different functional demands (interfaces with other systems, varying interlocking functions, user interfaces etc.).

ALISTERCARGO ADVANTAGES:

- Modular system concept with open interfaces to adjacent systems (i.e. communication, visualization, power supply etc.)
- Approved and well-known hardware and software components from the industrial automation sector, ex PLC and field bus technology (Profinet, ProfiSafe).
- System development in accordance with European standards (EN 50126/128/129)
- Safety Integrity Level SIL 0-2 in accordance with CENELEC and customer requirements.
- Low investment cost and economically advantageous spare parts resulting in low Life Cycle Costs.
- Simplified maintenance and easy to use diagnostic system.

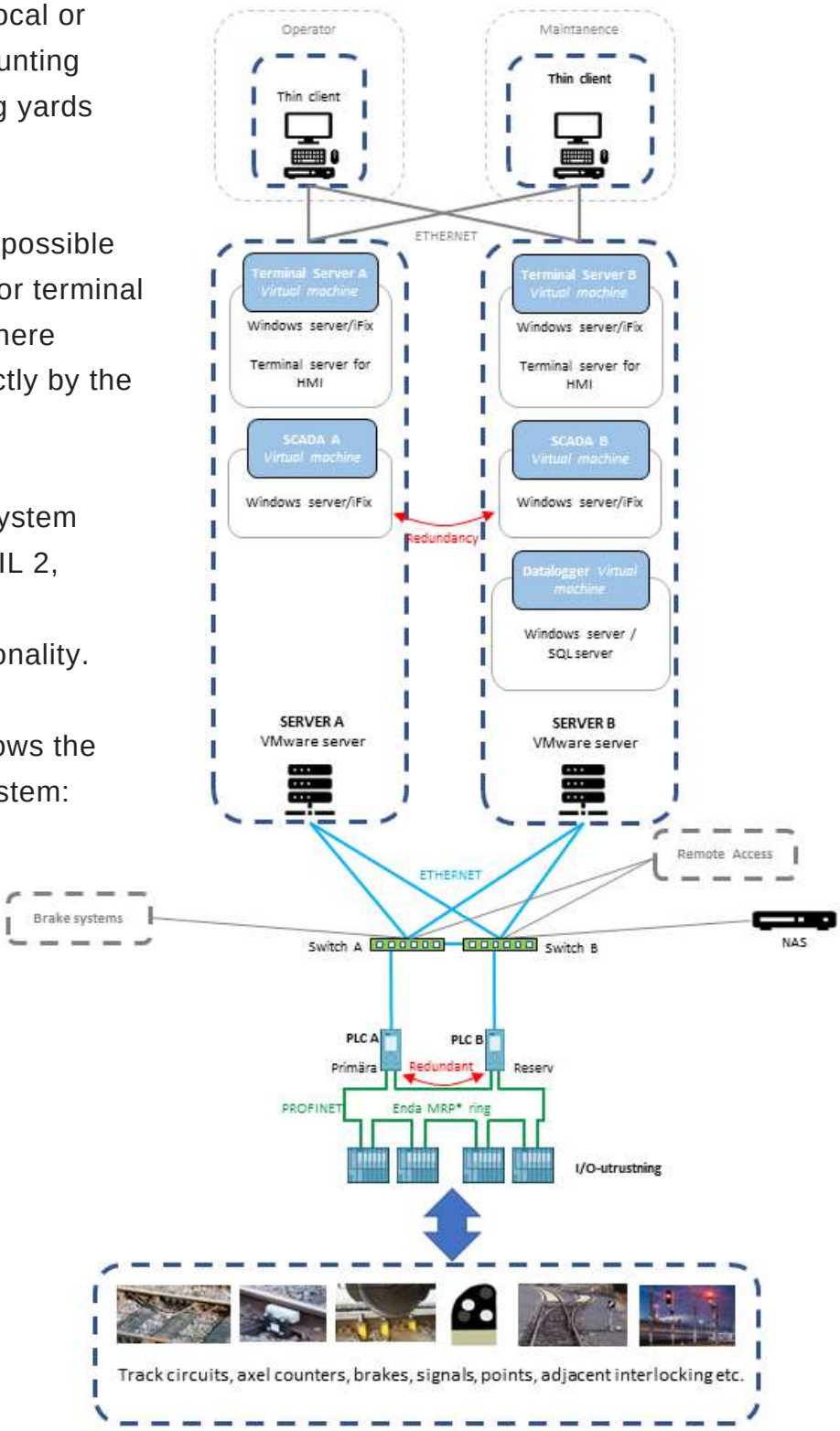
TECHNICAL DETAILS

AlisterCargo is an electronic interlocking system for local or centralised control of shunting routes within marshalling yards and depot areas.

Operating the system is possible through a central operator terminal or local driver panels, where routes are selected directly by the train driver.

The safety level of the system fulfils SIL 0 through to SIL 2, depending on customer requirements and functionality.

The illustration right, shows the generic design of the system:



TECHNICAL DETAILS

The core of the system is the two Siemens S7 redundant PLCs, which is connected to at se of IOs for communication with the physical elements of the marshalling yard (point, signals etc.). The 2 redundant PLCs host the interlocking part of the system.

Above the PLC is the connection to the systems SCADA servers, providing means of communication between operator/maintenance computers, control of dataflow and storage of incoming and outgoing data.

Both the PLC part and the SCADA part of the system are redundant to optimize the availability of the system.

Execution of the safety critical part of the system (interlocking functionality) is done in the PLCs. It is the part of the system which is build to meet the SIL requirements –no instructions or malfunctions from SCADA/HMI can cause a dangerous situation.

To extend the life-time of the system, all PC part can be virtualized. This ensures independence between available hardware spare part and the different standard software used in the system (Windows Server, SQL Server, iFix etc.)

The control of the trackside objects is connected to failsafe I/O modules in order to ensure failsafe positioning.

To ensure safe and reliable train detection, track circuits or an axle counter system is used, depending on customer requirements or pre-existing installations.

These provide the system with real-time, detailed information of the position of rolling stock and can be used for additional functions such as vehicle ID tracking, track parking occupancy, vehicle sorting etc.

If a system is equipped with driver's panels for local operation of the system, theses will be placed at the entrance to the depot area in a convenient position to be operated out of the open vehicle door. The figure below shows an example of the DSB project where the driver can operate the panel out of his opened cab window.

TRACKSIDE OBJECTS:

The AlisterCargo system controls all trackside objects, such as:

- Track circuits
- Axel counters
- Brakes
- Signals
- Point control machines
- Signals
- Adjacent interlocking
- Level crossings
- Driver's Panels for local operation of the system

The driver selects the desired route through the controlled sub-area by pushing the button for the desired destination track. The AlisterCargo system will check the route for conflict and routes that conflict with this selection will be indicated "occupied" at all other panels in the controlled sub-area.

Eventually as the points are aligned and the route is set permission to proceed over the controlled sub-area is granted. The route is now locked. Point operations within this route are no longer possible. At each point a Point Position Indicator or marshalling yard signal will indicate the position of the point or relevant traffic status.

After leaving the area the control system will release the route and is ready for new routes.

To exit the depot area from a parking track, the same procedure is used. Smaller Driver’s panels with more limited route maps are used (only exit track as option).

DRIVER’S PANEL AT DSB:

I/O System

The I/O system consists of Siemens standard I/O modules. Analog and digital, as well as failsafe and non-failsafe depending on what function they serve.
All I/O modules are connected to the central control system via fibre optic link. By using a fibre optic link, we ensure that possible over voltage cannot damage the central control system.

Central Control System

The central control system can be a failsafe PLC certified to SIL 2 in accordance with IEC61508. The PLC communicates with the non-failsafe I/O modules, via standard industry field bus PROFINET DP.

The communication is physically based on the use of fibre optic cables, advantageous because of speed, interface resistance and over voltage protection through electrical separation. In addition, the system is equipped with a fibre optic/copper converter.

The industry standard failsafe communication, PROFISafe, uses the same pair of fibre optic cables as the ordinary system PROFINET DP field bus.

The interface to the failsafe functions, point control, detection of occupied track segments via track circuits or wheel sensors, etc is handled by failsafe I/O modules, these also certified to SIL 2 in accordance with IEC61508.

SCADA System

The SCADA system is the layer between the PLC and the operator and maintenance terminals. The SCADA system contains a real-time database that is continuously updated with the latest information from the control system and distributes this data to operator and maintenance terminals. In reverse direction the SCADA interprets data from the operator and maintenance terminals, which after evaluation and pre-tests of the operator commands, dispatches these to the control system.

Equipment in Control Room / CTC

An operator terminal is installed in a control room / CTC, ideally in the marshalling yard / depot or possibly at a suitable remote location.

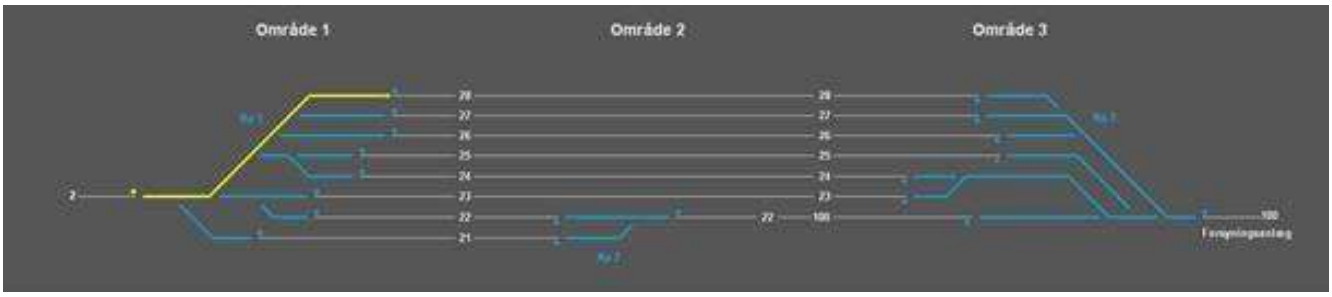
In the case local control through Driver’s panels has been chosen for the system design, the operator terminal will only be used for maintenance work.

The operator terminal consists of one workstation equipped with 2 to 4 (depending on track layout overview) monitors, keyboard, mouse, and other equipment in accordance with national regulations and customer specifications.

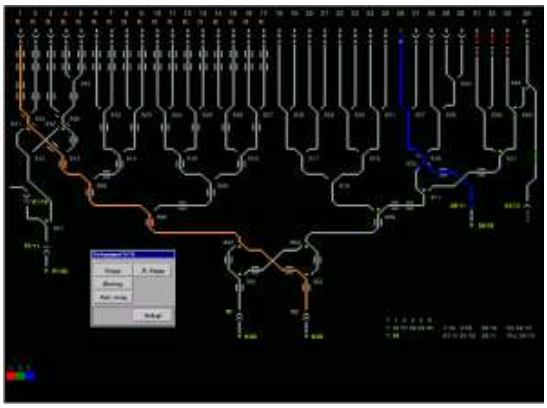
When central control of the marshalling yard or depot is required - a maintenance terminal would ideally be setup to monitor the status of the control system, including all fault messages and remarks.

The maintenance terminal has the same base functions as the operator terminal and thereby a total overview of the traffic situation at the marshalling yard. This ensures that the maintenance terminal can be used as a redundant operator terminal in case any problem or disturbance would arise with the main operator terminal.

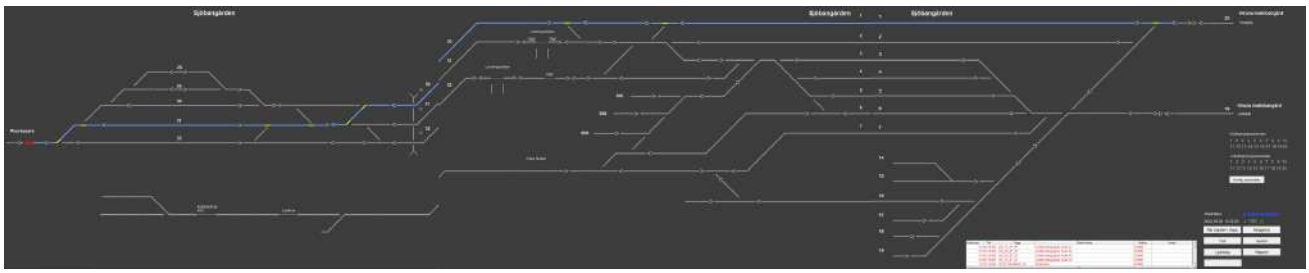
The maintenance terminal can also support playback functions, statistical reports, and other logging functionality.



Example of operator terminal overview screen at train depot



Example of operator terminal overview screen at humping yard



Example of operator terminal overview screen at marshalling yard

SYSTEM FUNCTIONALITY

The system enables interlocking functions, such as:

Function	Description
Shunting Route Setting	The main function of the interlocking system is to secure a shunting route between two chosen locations at the marshalling yard. The shunting route is locked when all points and flank protections on the route have come to the correct position and are locked. When locking the shunting route consideration is also taken to other interlocking rules, such as system status, occupancy of tracks etc.
Automatic Humping	Freight wagons are pushed over the hump and rolls down the hump-ing yard. The system ensures correct position of all points, to so that the individual wagons – or set of wagons - reach the intended track.
Train detection	All train/wagon movements are detected with wheel sensors or track circuits. This information is then used when executing the different interlocking rules and indicated in the operator display. The axle coun-ter/track circuit system will secure the controlled area.
Control of Signals	All signals at the marshalling yard are controlled by the interlocking system. Control of the signal aspect is done automatically as deter-mined by the status of the shunting route.
Control and Monitoring of Points	Points are normally controlled and monitored automatically and de-pendant on the demands for locking of shunting routes. Points can also be individually manoeuvred through operator setting of points and operator locking of points.
Automatic Route Setting	The manoeuvre system can perform all the usual functions, the most important function being automatic setting of routes through the depot yard, based on end destination together with occupancy and status information from tracks and points.
System Diagnostics	System status is monitored and logged for easier fault finding and maintenance.
Event and Alarm Logging	All events and alarms are logged for easier fault finding, statistics and playback.
Remote monitoring	The system is configured in such a way that it is very easy to setup a data exchange in order for a central CTC / traffic control centre to monitor the activities at the marshalling yard. For support and service purposes it is also recommendable for Rosenfelt & West to be able to remotely monitor an installed system from Sweden in order to swiftly and efficiently provide second line support (optional).
Interfaces to other sys-tems	The system provides all necessary interfaces to adjacent interlocking systems or other systems. All interfaces are designed in accordance with standard railway and industrial protocols.

REFERENCES

Trafikverket - Sweden

AlisterCargo is in operation in Sweden at Trafikverkets 4 main marshalling yards. The first one to be taken into operation, was Borlänge in 1997:

Marshalling yard	Number of tracks	Number of points
Borlänge	24	25
Göteborg	34	45
Malmö	26	27
Hallsberg	32	44

The functionality of these 4 marshalling yards includes train detection (track circuits), control of point machines, control of braking systems, control of signal to the train driver, route setting and hump yard functionality. The system is classified as a SIL 0 system.

REFERENCES

FTIA - Finland

AlisterCargo is in operation in Finland at Tampere marshalling yard. The system was taken into operation 2008.

Marshalling yard	Number of tracks	Number of points
Tampere	31	34

The functionality train detection (axel counters), control of point machines, control of braking systems, control of signal to the train driver, route setting and hump yard functionality. The system is classified as a SIL 0 system.

LKAB - Sweden

AlisterCargo is in operation in Sweden at 2 marshalling yards at LKAB. The first one to be taken into operation, was Borlänge in 1997:

Marshalling yard	Number of tracks	Number of points
Kiruna/Sjöbangården	12	32
Svappavaara	9	8

REFERENCES

DSB/Banedanmark - Denmark

AlisterCargo is in operation in Denmark in 11 train DSB and Banedanmark train depos. The first one to be taken into operation, was Odense in 2006:

Marshalling yard	Number of points
Østerport	5
Odense	14
Nykøbing Falster	18
Helgoland	13
Helgoland II	9
Aarhus 400 Gruppen	3
Aarhus P Rist	16
Aarhus	24
Aalborg	10
Fredericia	37
Kalundborg	6

The functionality of these 11 depots includes train detection (axel counters), control of point machines, control of signal to the train driver and manual route setting from panels. The system is classified as a SIL 2 system.

Contact:

Rosenfelt & West Engineering A/S
Rådhus Allé 7
DK-3650 Ølstykke

Phone: +45 47 100 200
Email: info@rwe.dk